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We claim:

1        1. A heat exchanger for transferring heat between a first fluid and a second fluid;  
2 wherein said heat exchanger comprises first fluid channels through which the first fluid may flow,  
3 and second fluid channels through which the second fluid may flow, wherein said second fluid  
4 channels lie generally in a plane; wherein said first fluid channels and said second fluid channels  
5 interleave, so that heat may be transferred between said first fluid channels and said second fluid  
6 channels; wherein the direction of flow of said first fluid channels is generally perpendicular to the  
7 plane of said second fluid channels; and wherein said heat exchanger has a density of said first fluid  
8 channels greater than about 50 per square centimeter.

1        2. A heat exchanger as recited in Claim 1, wherein said first fluid channels are adapted  
2 for the flow of a gas, and wherein said second fluid channels are adapted for the flow of a liquid.

1        3. A heat exchanger as recited in Claim 1, wherein the thickness of said heat exchanger,  
2 in the direction of flow of said first fluid channels, is less than about 2.0 mm.

1        4. A heat exchanger as recited in Claim 1, wherein the thickness of said heat exchanger,  
2 in the direction of flow of said first fluid channels, is less than about 1.0 mm.

1           5. A heat exchanger as recited in Claim 1, wherein the width of said second fluid  
2 channels, in a direction that is generally perpendicular to the direction of flow of said first fluid  
3 channels and is also generally perpendicular to the direction of flow of said second fluid channels,  
4 is less than about 500  $\mu\text{m}$ .

1           6. A heat exchanger as recited in Claim 1, wherein said heat exchanger has a density of  
2 said first fluid channels greater than about 200 per square centimeter.

1           7. A heat exchanger as recited in Claim 1, wherein the thickness of said heat exchanger,  
2 in the direction of flow of said first fluid channels, is less than about 1.0 mm; wherein the width of  
3 said second fluid channels, in a direction that is generally perpendicular to the direction of flow of  
4 said first fluid channels and is also generally perpendicular to the direction of flow of said second  
5 fluid channels, is less than about 500  $\mu\text{m}$ ; and wherein said heat exchanger has a density of said first  
6 fluid channels greater than about 200 per square centimeter.

1           8. A heat exchanger as recited in Claim 1, wherein said heat exchanger is fabricated  
2 from a polymer.

1           9. A heat exchanger as recited in Claim 1, wherein said heat exchanger is fabricated  
2 from a ceramic.

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1           **10.**    A heat exchanger as recited in Claim 1, wherein said heat exchanger is fabricated  
2           from copper.

1           **11.**    A heat exchanger as recited in Claim 1, wherein said heat exchanger is fabricated  
2           from aluminum.

1           **12.**    A heat exchanger as recited in Claim 1, wherein said heat exchanger is fabricated  
2           from metal.

1           **13.**    A heat exchanger as recited in Claim 1, wherein the thickness of said heat exchanger,  
2           in the direction of flow of said first fluid channels, is less than about 6.0 mm.

1           **14.**    A heat exchanger as recited in Claim 1, wherein the width of said second fluid  
2           channels, in a direction that is generally perpendicular to the direction of flow of said first fluid  
3           channels and is also generally perpendicular to the direction of flow of said second fluid channels,  
4           is less than about 2.0 mm.

1           **15.** A heat exchanger as recited in Claim 1, wherein the thickness of said heat exchanger,  
2 in the direction of flow of said first fluid channels, is less than about 6.0 mm, and wherein the width  
3 of said second fluid channels, in a direction that is generally perpendicular to the direction of flow  
4 of said first fluid channels and is also generally perpendicular to the direction of flow of said second  
5 fluid channels, is less than about 2.0 mm.

1           **16.** A heat exchanger for transferring heat between a first fluid and a second fluid;  
2 wherein said heat exchanger comprises first fluid channels through which the first fluid may flow,  
3 and one or more second, multiply interconnected fluid channels through which the second fluid may  
4 flow; wherein said first fluid channels and said second fluid channels interleave, so that heat may  
5 be transferred between said first fluid channels and said second fluid channels; wherein the direction  
6 of flow of said first fluid channels is generally perpendicular to the direction of flow of said second  
7 fluid channels; wherein the thickness of said heat exchanger, in the direction of flow of said first  
8 fluid channels, is less than about 6.0 mm; and wherein said heat exchanger has a density of said first  
9 fluid channels greater than about 50 per square centimeter.

1           **17.** A heat exchanger as recited in Claim 16, wherein said first fluid channels are adapted  
2 for the flow of a gas, and wherein said second fluid channels are adapted for the flow of a liquid.

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1           **18.** A heat exchanger as recited in Claim 16, wherein the thickness of said heat  
2 exchanger, in the direction of flow of said first fluid channels, is less than about 2.0 mm.

1           **19.** A heat exchanger as recited in Claim 16, wherein the thickness of said heat  
2 exchanger, in the direction of flow of said first fluid channels, is less than about 1.0 mm.

1           **20.** A heat exchanger as recited in Claim 16, wherein said heat exchanger has a density  
2 of said first fluid channels greater than about 200 per square centimeter.

1           **21.** A heat exchanger as recited in Claim 16, wherein the thickness of said heat  
2 exchanger, in the direction of flow of said first fluid channels, is less than about 1.0 mm; and  
3 wherein said heat exchanger has a density of said first fluid channels greater than about 200 per  
4 square centimeter.

1           **22.** A heat exchanger as recited in Claim 16, wherein said heat exchanger is fabricated  
2 from a polymer.

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1           **23.**   A heat exchanger as recited in Claim 16, wherein said heat exchanger is fabricated  
2 from copper.

1           **24.**   A heat exchanger as recited in Claim 16, wherein said heat exchanger is fabricated  
2 from aluminum.

1           **25.**   A heat exchanger as recited in Claim 16, wherein said heat exchanger is fabricated  
2 from metal.

1           **26.**   A heat exchanger as recited in Claim 16, wherein said heat exchanger is fabricated  
2 from a copper alloy.

1           **27.**   A heat exchanger as recited in Claim 16, wherein said heat exchanger is fabricated  
2 from a nickel-boron alloy.

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1           **28.**   A method for fabricating a cross flow heat exchanger as recited in Claim 16, said  
2 method comprising the steps of:

3           **(a)** manufacturing a polymer sheet having a plurality of holes traversing the sheet, wherein  
4 the portions of the sheet containing polymer correspond to the one or more second fluid  
5 channels, and wherein the holes correspond to the first fluid channels;

6           **(b)** plating at least one layer of metal on the surfaces of the polymer sheet, including plating  
7 metal on the walls of the holes, but without completely filling the holes with metal; and

8           **(c)** removing the polymer without removing the metal;

9           **(d)** whereby the metal structure remaining after removal of the polymer is a cross flow heat  
10 exchanger as recited in Claim 16, wherein the spaces in the metal structure where the  
11 polymer previously had been become the one or more second fluid channels, and wherein the  
12 holes that originally traversed the polymer sheet become the first fluid channels.

1           **29.**   A method as recited in Claim 28, additionally comprising the step of manufacturing  
2 the polymer sheet by x-ray lithography or by the LIGA process.

1           **30.**   A method as recited in Claim 28, wherein said sheet comprises poly(methyl  
2 methacrylate).

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1           **31.**   A method as recited in Claim 28, wherein said removing step comprises dissolving  
2           the polymer.

1           **32.**   A method as recited in Claim 28, wherein said removing step comprises melting the  
2           polymer.

1           **33.**   A method as recited in Claim 28, wherein said plating step comprises electrode-less  
2           plating of a metal layer.

1           **34.**   A method as recited in Claim 33, wherein said electrode-less plating step comprises  
2           first, sputtering onto the polymer sheet a first metal layer having a thickness about 1  $\mu\text{m}$  thick or less,  
3           and second, catalytically depositing onto the first metal layer a second metal layer having a thickness  
4           between about 25  $\mu\text{m}$  and about 150  $\mu\text{m}$ .